Aerospace Environment

Originally, war, like man, was confined to land. Eventually, man's curiosity and inventiveness carried warfare into a different environment—the sea—whose singular characteristics altered the conduct of war. The newest realm of warfare is the aerospace environment which, for practical purposes, was unlocked at Kitty Hawk in 1903.[1] Like the land and sea, the aerospace environment has its distinctive characteristics, its own set of advantages and limitations. To understand warfare in this environment, we must briefly examine the natures of the surface environments and how their characteristics have affected warfare.

Land Environment

Experience in land warfare teaches that the combatant who has control of higher ground holds a decided advantage over his opponent. From his elevated vantage point, the holder of high ground has an improved ability to observe the enemy. Additionally, from higher ground, a combatant works with gravity in converting potential energy to kinetic energy as he strikes the enemy. On the other hand, a combatant on lower ground has to work against gravity to attack.

Beyond concerns about the high ground, land forces must contend with land's complexity. This complexity is caused primarily by the roughness and load-bearing capacity of the surface. Roughness is determined by elevation, gradient, and the frequency with which gradient changes. Load-bearing capacity adds to land's complexity because it varies with location, weather, and traffic. Vegetation and man-made structures add further complexity.[2]

The complexity of land is important in warfare for a variety of reasons; two of the most important being its effects on mobility and survivability. Complexity influences mobility by determining what type of force (mechanized or not) can move where and how quickly, and what support forces need (in terms of food, water, energy, and engineers). Complexity influences survivability by its effect on the probability a force will be detected and the amount of damage that

force will suffer if detected. In short, surface complexity influences the success of concealment and deception measures, as well as the ability to disperse and take cover.

Sea Environment

The sea does not possess the complexity of land. Its fluid nature, however, introduces some unique considerations. To exist at sea, let alone move or fight, man depends on ships. Ships are the key to mobility and survivability. The design, including size, of ships affects where they can move, how fast, and in what sea conditions. Design also affects survivability in a variety of ways. Increasing size can increase survivability by making a ship more difficult to sink, but larger size can make a ship easier to find. Design also affects the number and type of weapons a ship can carry, which can influence how well the ship can defend itself and how far it can project power across the sea or onto the land.

Sea forces must contend with territorial-water limits and other political boundaries, even though these have a less restrictive effect on transit of the sea than they have on movement over land. Despite their added mobility, sea forces share a common limitation with land forces. Neither can advance far into the other's domain.

Giulio Douhet's comments on the surface environments in his classic, *The Command of the Air*, serve well as a summary of this discussion.

> As long as man remained tied to the surface of the earth, his activities had to be adapted to the conditions imposed by that surface. War being an activity which necessitates wide movements of forces, the terrain upon which it was fought determined its essential features. The uneven configuration of the land surface presents all kinds of obstacles which hinder movements of solid bodies over it. Hence man has had either to move along the lines of least resistance, or by long and arduous labor surmount the obstacles encountered in the more difficult zones.
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> The sea, on the contrary, being everywhere uniform in character, is equally navigable over all parts of its surface. But because the sea is bound by coastlines, freedom of navigation is often precluded except between points of

> contact situated on the same coastline or along arbitrary routes under foreign control, to avoid which long journeys around the coasts themselves must be undertaken.[3]

Land-Sea Transition Zone

A natural and distinct boundary exists between the realms of land and sea power, but there is also a transition zone where land power can directly influence sea power and vice versa.[4] Sea forces can be used to accomplish an objective in a land campaign, as in Gen Douglas MacArthur's amphibious operation at Inchon, and land forces can be used to secure naval ports or facilities, as in the fall of Singapore to the Japanese in 1942.[5] However, beyond the transition zone, land and sea forces generally must fight independently of one another. This is not to say that the efforts of one do not have an effect on the other, for they certainly do, but it does say that their actions directly affect each other only in the transition zone between them.

The Third Dimension

With the advent of the airplane, warfare entered a third dimension—aerospace.[6] This vertical dimension has two related characteristics that differ significantly from those of the surface environment. First, the aerospace environment has only one distinct boundary—the earth's surface; no lateral boundaries restrict movement within it. Second, the environment extends from the earth's surface toward infinity. The key element in both of these characteristics is elevation above the surface which, in turn, leads to the qualities of aerospace power: perspective, speed, range, and three-dimensional maneuverability.

A Single Boundary

With regard to the first characteristic, Douhet said, "The surface of the earth is the coastline of the air."[7] Just as ships must carefully avoid reefs and shoals near the coastline, aerospace forces cannot with impunity disregard obstacles at the "coastline" of the aerospace environment. However, the technology that gives aerospace

platforms access to the environment also provides the method of overflying or circumnavigating such obstacles. Surface features also affect aerospace forces when such forces are on the ground (i.e., their survivability and operability which depend in part on the load-bearing capacity of base and launch facilities).

Despite these restrictions, the aerospace environment allows aerospace forces to take the mobility of sea forces a step further. While sea forces can go anywhere there is sea, aerospace forces can, within technical limits, go anywhere there is aerospace. Since the earth is entirely surrounded by air and space, all points on its surface are accessible from the aerospace environment. Similarly, aerospace has no natural lateral boundaries—no physical obstacles its forces cannot surmount. Because there are no lateral boundaries, aerospace forces can operate above both land and sea and can with ease cross the boundary that separates them. As Gen William "Billy" Mitchell noted,

> As the air covers the whole world, aircraft are able to go anywhere on the planet. They are not dependent on the water as a means of sustentation, nor on the land, to keep them up. Mountains, deserts, oceans, rivers, and forests, are no obstacles.
>
> Aircraft have set aside all ideas of frontiers. The whole country now becomes the frontier and, in case of war, one place is just as exposed to attack as another place.[8]

Although there are no physical obstacles in the aerospace environment, nations do regard their air space as sovereign and can deny overflight rights even in peacetime. On the other hand, no political boundaries have been established in space, and free access to the entire globe is available from space.[9]

Unlimited Elevation

The second characteristic of aerospace is that it begins at the earth's surface and extends upward toward infinity. As with the sea, man depends on platforms to operate in the environment. Positioning of those platforms in the aerospace environment can be equivalent to the control of high ground sought from the earliest days of land warfare.

Forces operating in this environment can use gravity to convert potential energy into kinetic energy in striking forces on the surface. Forces in higher positions have the same advantage over forces lower in the aerospace environment. Aerospace forces can also use their elevated positions to better observe their opponents.

The aerospace environment consists of a continuum of qualities that starts near the earth's surface with the fluid characteristics of the atmosphere and gradually changes with altitude to the vacuum of space. More technologically advanced means are required to obtain access to, and to operate within, the higher reaches of the environment. Operations in the vertical dimension consume great amounts of energy (this holds true even for lighter-than-air platforms as energy is consumed obtaining helium or other lifting substance). Energy may be expended continuously, requiring frequent air refueling or returns to the surface to replenish fuel, or it may be expended quickly in tremendous amounts to obtain earth orbit with little further fuel requirements.

Although aerospace is a continuum that extends upward toward infinity, no single platform yet has the capability to exploit the environment completely. For example, the technology that allows aircraft to fly is primarily dependent on aerodynamic lift. (Lift provided only by thrust can be used for limited periods.) Aircraft cannot climb beyond the point where the atmosphere becomes too thin to produce lift. Beyond that point, a different kind of technology is required.

Some people have seized on the differences in air and space technologies to argue that space constitutes a separate environment from the air and that space requires development of a separate force to exploit it just as the land, sea, and air environments require separate forces.[10] This argument is equivalent to saying that submarines and surface ships should be in separate force structures. Although there are many differences between submarine and surface craft, the important quality they share is that they both operate at sea. Infantry and armor use quite different technologies as well, but they do not require separate services because their significant unifying characteristic is that

they both operate on land. Similarly, the important quality that air and spacecraft share is that they operate above the earth's surface. Moreover, no sharp boundary exists between air and space, while it is quite obvious when one moves from land to sea or from aerospace to land or sea. The difference between atmosphere and space is obvious, but where the transition takes place is not clear.

In the final analysis, elevation and freedom of movement are the keys that distinguish the aerospace environment from the surface environments and bind air to space. Elevation is the characteristic that does not change in kind—only in amount—as one ascends from air to space. Freedom of movement and speed underscores the military usefulness of exploiting air and space. While no current platform has the ability to completely exploit the full spectrum of the aerospace environment, the planned development of an aerospace plane to operate both in the atmosphere and in space serves to illustrate the continuity of aerospace.[11] Its continuity is further evidenced by the fact that conceptually many of the same military activities can be performed in air and space, even though different platforms (some of which are yet to be developed) and somewhat different methods must be used to perform them. Thus, from a military, as opposed to an engineering perspective, the aerospace environment must be considered as an indivisible whole.

Space technology, as it continues to develop, will allow man to exploit more fully the entirety of the aerospace environment. Rather than opening a new environment, advanced space technology will allow more complete access to the one the Wright brothers opened on 17 December 1903.[12]

Aerospace-Surface Transition Zone

Just as there is a transition zone between the land and sea, there is a transition zone between the aerospace and surface environments where aerospace forces intermix with, support, and are supported by surface forces.[13] The interdependence of surface and aerospace forces is nowhere more evident than in the function of the modern aircraft

carrier. Here, sea forces provide a mobile operating base from which aerospace forces can project power. At the same time, the aerospace forces provide protection for the sea forces. Similarly, land and aerospace forces can support each other. An example is the close air support rendered to land forces at Khe Sanh.[14] Ground forces can also support aerospace forces as in the Israeli land forces attack on surface-to-air missile (SAM) sites in the Sinai during the 1973 Yom Kippur War.[15]

Unifying Effect

In some ways the aerospace environment consolidates the qualities of the land and sea environments. For example, it combines the potential energy and observational advantages of the high ground desired by land forces with the advantage of speed found to be so valuable by early sea power strategists. Because it envelops the globe, aerospace also has a unifying effect on the conduct of warfare. Land and sea forces that once had to work independently can now coordinate and cooperate with aerospace forces to produce a more effective combat team. This synergism is not a change in the fundamental nature of war, but it is a fundamental change in the way war is conducted. As Douhet said in 1929, "Nowadays anyone considering land and sea operations of any importance must of necessity remember that above the land and sea is the air."[16] Although he might today change the last word to aerospace, he would be delighted that modern space systems have made this concept all the more universal.

Notes

1. From a historical standpoint, the opening of the aerospace environment is interesting because it has been chronicled by those contemporary with the events, and those records are available for study. Early developments of the land and sea environments took place before man began to keep such records.

2. Richard E. Simpkin, *Race to the Swift* (London: Brassey's Defence Publishers, 1985), 57–77.

3. Giulio Douhet, *The Command of the Air*, trans. Dino Ferrari (New York: Coward-McCann, Inc., 1942), 7–8.

4. Carl Builder, *The Masks of War: American Military Styles in Strategy and Analysis* (Baltimore: Johns Hopkins University, 1989), 61. Builder gives light to the separateness of the land and sea environments and the concept of transition zones when he says,

> Before the advent of aircraft, the boundary between land warfare and sea warfare was relatively sharp, with only subordinate elements of the Navy and Army—the Marines and Coast Defense Artillery—operating at their interface. The mainstream doctrinal interests of the Army and Navy, therefore, overlapped only at the margin until airplanes, based on land or sea, demonstrated the ability to reach deeply and importantly across the shoreline.

5. The British guns that protected the port at Singapore were oriented toward the sea. Rather than risk the loss of ships in an approach from the sea, the Japanese attacked Singapore from the rear using land forces that had marched down the Malay Peninsula. The land forces thus secured the port for the use of the Japanese navy. For a detailed description of this campaign, see Kenneth Attiwill, *Fortress: The Story of the Siege and Fall of Singapore* (Garden City, N.Y. : Doubleday & Co., Inc., 1960).

6. Air Vice-Marshal R. A. Mason, ed., *War in the Third Dimension: Essays in Contemporary Air Power* (London: Brassey's Defence Publishers, 1986), 2. This book contains several enlightening essays on how warfare has been changed by exploitation of the third dimension and the development of aerospace power.

7. Douhet, 19.

8. Maj Gen William Mitchell, *Winged Defense: The Development and Possibilities of Modern Air Power—Economic and Military* (Port Washington, N.Y.: Kennikat Press, first published in 1925, reissued in 1971), 4.

9. Lt Col David E. Lupton, *On Space Warfare: A Space Power Doctrine* (Maxwell AFB, Ala.: Air University Press, June 1988), 25–26.

10. Mason, 1. In discussing the potential for space warfare to revolutionize warfare Air Vice-Marshal Mason says,

> It might be salutary for those who believe that thereby warfare would be revolutionised, to reflect upon the prophecies of the early air power enthusiasts and the time which elapsed before their fulfillment. After three-quarters of a century, it can be argued that less emphasis on the "revolutionary" aspects of air warfare and a more sturdy grafting of new ideas on to those repeatedly illustrated in the history of war on land and sea would have actually accelerated and enhanced the impact of air power. There is, however, nothing so clear as 20:20 hindsight.

11. The National Aerospace Plane is a technological development effort which aims to produce fully reusable hypersonic platforms capable of horizontal takeoff

from runways, direct transit into earth orbit, and return to runways. Such platforms will also have the ability to fly in the atmosphere at speeds up to Mach 25.

12. The aerospace environment was breached much earlier by balloons and other lighter-than-air systems; however, until practical heavier-than-air flight was demonstrated, the environment was not truly opened. For a description of these developments, including the Wright brothers' experience, see M. J. Bernard Davy, *Air Power and Civilization* (London: George Allen & Unwin Ltd., 1941).

13. For a discussion of the advantages certain kinds of forces have at the transition zones or environmental boundaries, see Lupton, 144.

14. Gen William W. Momyer, *Airpower in Three Wars* (Washington, D.C.: Government Printing Office, January 1978), 305–11.

15. Peter Allen, *The Yom Kippur War* (New York: Charles Scribner's Sons, 1982), 227–80. In the 1973 Yom Kippur War, a strong SAM umbrella protected Egyptian forces from Israeli air attack. Israeli aircraft could not effectively assist the ground advance across the Suez until a corridor was cut through the SAM belt. Israeli ground forces were directed to make selected surface-to-air missile sites priority targets. Destruction of the sites made possible Israeli air support for ground efforts on the west side of the canal. Some have referred to this as close ground support—the counterpart to close air support.

16. Douhet, 218.